

ADVISORY COUNCIL ON SCIENCE AND TECHNOLOGY

REPORT OF RECOMMENDATIONS

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ADVISORY COUNCIL ON
SCIENCE AND TECHNOLOGY
REPORT OF RECOMMENDATIONS

Submitted to:

The Honorable Ted Schwinden
Governor of Montana

December 1984

DEPARTMENT OF COMMERCE



TED SCHWINDEN GOVERNOR

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STATE OF MONTANA

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HELENA, MONTANA 59620-0401

December 3, 1984

The Honorable Ted Schwinden
Governor of Montana
State Capitol
Helena, Montana 59620

Dear Governor Schwinden:

On behalf of the Montana Advisory Council on Science and Technology, I am pleased to submit to you our Report of Recommendations. Contained herein are the Advisory Council's recommendations, including the major recommendation for a 10-year, private and public investment program to foster economic growth through technology development and application in Montana.

Our technology development program, which has the unanimous support of the Advisory Council members, presents a bold and visionary approach to securing opportunities for technological-based economic growth and job development in Montana. It is based on an alliance among business, state government, and academic institutions working in partnership. As you have shown in initiating the "Build Montana" program, the state can successfully play a practical role in economic development. The technology development program recommended by the Advisory Council would be a major state effort to secure a better economic future in Montana through technological innovation.

Enthusiasm and support for the proposed program is high among Montanans. Greater utilization and further development of technology-intensive businesses in Montana is viewed as an appropriate and necessary course now and in the future. There is a general feeling that Montana is at a critical point in time and that bold action must be taken if we are to secure an improved economic future.

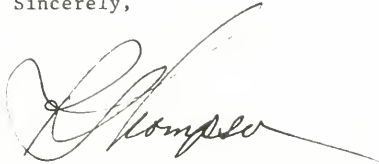
The Advisory Council believes that it is appropriate to use the permanent Coal Tax Trust Fund to support a program of technology development. The citizens declared, with the passage of Initiative 95 in 1982, that a primary intent of this Fund is to develop a stable, strong, and diversified economy for present and future Montana residents while maintaining and improving a clean and healthful environment. Council members believe that investment to encourage and assist technology development clearly meets this intent.

I have enjoyed the opportunity and privilege of chairing your Advisory Council of enthusiastic and dedicated men and women who gave generously of their time and abilities on behalf of our state. I wish to thank the Advisory Council

staff for their commitment. We were fortunate to receive the views of many people and groups through our subcommittees, our Council meetings around the state, and at public hearings. Our recommendations were formed from the views of many hundreds of Montanans. Together, we present you a program which will help move Montana to technological leadership and provide a prosperous and sustainable economic future for our state.

It has been a most rewarding process and, on behalf of the Advisory Council, I express our gratitude for the opportunity to serve Montana in this endeavor.

Sincerely,

A handwritten signature in dark ink, appearing to read "R. Thompson", with a long, sweeping horizontal line extending to the right.

Raymon F. Thompson, Chairman
Advisory Council on Science and Technology

RFT/gp

Enclosure

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SECTION I

EXECUTIVE SUMMARY

A. Background:

Dramatic changes in the economic structure of the nation have led to the displacement of many traditional industries and a growing concern about the future. Montana has been severely affected as well. However, greater application of technology by existing businesses and new advanced technology business and industry has the potential to make a positive, long-term contribution to Montana's economic future, including opportunities for new jobs and for an expanding and diverse economy.

To attain these economic improvements will require bold new initiatives, operating in a spirit of public and private cooperation, which combine the talents and resources of business, industry, education, labor and government. The members of the Advisory Council on Science and Technology, based on their study and from input obtained from subcommittee participants and the public, believe that combined public and private action must begin if Montana is to be competitive and nurture technology development to secure a better economic future while maintaining a quality environment.

B. Advisory Council on Science and Technology:

Governor Ted Schwinden, on October 20, 1983, established the Advisory Council on Science and Technology to first, help existing Montana businesses, farmers and ranchers, professionals, and industrialists use technology to compete in an advanced technology economy, and second, support new advanced technology development in Montana. The Governor requested that the Advisory Council examine the possibility of establishing a partnership between business, state government, colleges and universities, and vocational training centers having the purpose to ensure that research and technology are put to practical use in Montana's economy.

C. Subcommittees:

Ad-hoc subcommittees helped the Advisory Council evaluate the present economic situation, explore opportunities and ideas for using science and technology advantageously in economic development, and to prepare recommendations. Nine informal subcommittees were established with about 150 participants. Subcommittees worked in the following areas: Agriculture Technology; Biotechnology; Computers, Electronics and Materials Science; Energy and Energy Conservation; Financing and Commercialization of R&D; Forestry Technology; Information Dissemination; Mineral Technology; and Technical Education. The subcommittees' suggestions, ideas, and conclusions guided formulation of Advisory Council's recommendations.

D. Findings:

The conclusion of the Advisory Council on Science and Technology is that timely, shared, public and private sector investment to stimulate technology and scientific investigation represents a significant opportunity for Montana business to become more productive and competitive. Such an investment will also make Montana more attractive for the start-up and expansion of advanced technology firms.

The Advisory Council believes that a course of action should be undertaken immediately to revitalize and diversify the state's traditional strengths in agriculture, minerals, energy, forest products and small manufacturing as well as encouraging economic growth in new emerging areas such as biotechnology, electronics and computer sciences, communications and information sciences, and materials science.

E. Major Recommendation:

(1) An Alliance for Science and Technology Development:

Public and private resources should be combined and invested in an alliance organization to provide scientific and technological support for Montana industries and businesses, to improve their competitiveness and to bring new technological opportunities to the state. Other states are taking similar actions and are investing significantly in indigenous technological development. The Advisory Council believes that Montana, too, must take bold steps. Therefore, a major partnership program to foster technological development in Montana is being recommended.

(2) Organization:

Proposed is an Alliance for Science and Technology Development, operating as a partnership of business and industry, universities and colleges, vocational education, labor and state government. The purpose of the Alliance would be to facilitate shared investment in promising ideas, programs and projects proposed by private and public organizations and institutions. An organizational structure for the Alliance is shown in Figure 1 in Section IV.

(3) Program:

The Alliance would have four complementary investment programs:

a. Matching Research Investments:

- Project-oriented.
- Alliance would jointly invest in product development projects of industry, university and colleges, and other research and development organizations.
- A match of 100 percent expected from cooperators:
- Only projects having potential for commercial products or processes leading to in-state jobs and investments would be supported.
- An equitable portion of royalties and license fees would accrue to the Alliance.

b. Research Capability Investments:

- Program-oriented.
- Alliance would invest in the creation or strengthening of in-state, private and public R&D capabilities supportive of business and economic development.

- Preference given if matching funds are available.
- Priority given to investments supporting partnership arrangements between business and industry and University System units.

c. Technology Transfer and Technical Assistance Investments:

- Invest in programs providing technical assistance and transferring technology to business and industry, training centers, schools and the general public.
- Preference given if matching funds are available.

d. Seed Capital Financial Investments:

- Investments would provide financial leverage to encourage private sector seed capital formation (early stage financing) which presently is difficult to obtain.
- Montana Economic Development Board would administer this financial program for the Alliance.
- Returns on investment would accrue to the Alliance.
- Financial investment will be considered only if financial intermediary has equal dollars-at-risk.
- Investment opportunities too large for funding by this program would be accepted, evaluated and referred to the Montana Board of Investments for possible investment.

(4) Criteria for Investment

Three criteria would guide the investment made by the Alliance:

- a. Contribution to economic development and job creation.

- b. Quality of work or service performed.
- c. No duplication of existing facilities, ongoing programs, projects, or work.

A competitive review process would be used to select all investments.

(5) Targeted Technologies

Eight technologies are believed to have the highest potential for enhancing economic growth. These technologies complement existing business and industry as well as new industry:

- mineral technology
- agricultural technology
- forestry technology
- energy technology
- materials science
- information services
- biotechnology
- microelectronics and computer sciences

Other technologies, however, would be eligible for investment.

(6) Annual Alliance Budget

An annual Alliance budget of six million dollars (\$6,000,000) is needed over a 10-year period. Additionally, matching is expected at \$4 million. Together, the Alliance investment, plus matching, creates a 10-year, \$10-million a year, technology investment program.

The Advisory Council also believes that funding of the Alliance and its economic development investment programs should be from the Coal Tax Trust Fund. A proposed annual budget for the Alliance is shown in Table 1 in Section IV.

F. Other Recommendations:

The Advisory Council, in addition to its major recommendation for an Alliance for Science and Technology Development, has six other recommendations:

(1) Endorsement for University System Budget Modifications:

The University System and its units are proposing to the Legislature new or expanded programs that would assist and encourage research and technological development and provide small business assistance. The Advisory Council endorses these budget modifications and recommends that the Legislature support them.

(2) Commercialization of University Research:

The University System should:

- a. examine existing patenting, licensing and commercialization services and expand and enhance these services within the entire system, and
- b. develop a system-wide policy allowing Montana firms to have first opportunity to commercialize University research.

(3) Science and Technical Education:

This recommendation requests strengthening in the following areas relating to scientific and technical education and training: teacher training, vocational education, skills development, industrial involvement, career opportunities, information networks, opportunities for women and minorities, and continuing education.

(4) Research Technology Parks and Technology-Based Incubator Facilities:

The proposed Alliance for Science and Technology Development and the Department of Commerce should evaluate the feasibility of research/technology parks and technology-based business incubator facilities. Investments from the proposed Alliance's research capability program should be used for feasibility studies and initial planning.

(5) Telecommunication Corporation:

A temporary committee should be formed by the board of the proposed Alliance to plan, develop and launch a new private, non-profit corporation. The corporation would inventory, plan, coordinate and pool available telecommunication resources both public and private, into an efficient system. The committee should exist for two years and receive \$200,000 in funding from the proposed technology transfer and technical assistance program.

(6) Research Chairs to Support Cooperative Research:

Establish within the University System a program of seven distinguished research chairs to support the research needs of

existing industry as well as emerging advanced technology industries. Estimated cost would be \$700,000 annually (\$100,000 per chair) with funding from the proposed Alliance's Research Capability Investments Program. Private sector matching is expected.

SECTION 11

BACKGROUND

A. Temporary Committee Efforts:

A temporary committee to sponsor creation of a committee (board) on science and technology was established informally in 1982 as preplanning for the "Build Montana" program. The temporary committee recommended the creation of a Board of Science and Technology having authority to (1) apply for and accept grants of money from private and public sources, including appropriations from the legislature, and (2) award grants and contracts to individuals, business entities, public agencies, colleges and universities to do research and development projects primarily in Montana that complement and support economic development.

B. "Build Montana":

Governor Ted Schwinden, as part of his "Build Montana" program, recommended establishment of a nine-member Science and Technology Council to be attached to the Department of Commerce. The Council would develop strategies and implement plans to obtain public and private funding for continuous support of multi-year research and development projects and programs which would enhance economic development. A biennium budget of \$197,414 was proposed.

C. Legislative Action:

The 1983 Legislature appropriated \$100,000 in House Bill 1, for the creation of an Advisory Council to advise the Department of Commerce on the application of science and technological research in the development and implementation of economic development programs.

D. The Governor's Advisory Council on Science & Technology:

The Governor, in response to passage of House Bill 1, established on October 20, 1983, an Advisory Council on Science and Technology and appointed 11 members. The purpose of the Council is to study the existing and potential science and technology resources in the state, and use this information for developing long and short-range plans for economic development. The 11 Advisory Council members represent a cross-section of scientific, industrial, financial and agricultural backgrounds.

(1) Mission:

Governor Schwinden, speaking at the first meeting of the newly created Advisory Council on Science and Technology, October 31, 1983, charged the members with this challenge:

... the first order of business for this Council should be applying scientific technologies to existing Montana businesses and industry. Helping Montana businesses, farmers and ranchers, professionals and industrialists use state-of-the-art technology in order to compete in tomorrow's high-tech-oriented business world must be our primary goal. Only after that should we consider starting up new technology-based businesses in Montana.

The Governor requested recommendations to do the following:

- expand and use the capabilities of research universities in partnership with business and industry;
- apply science and technology to Montana businesses and industries to help improve their productivity and competitiveness;
- assure that students at all educational levels receive necessary technical and science education; and
- train and retrain workers in necessary skills to obtain work in business and industry.

(2) Goals:

The Advisory Council on Science and Technology, in response to the direction given by the temporary committee, and the directives of the legislature and the Governor, adopted the following objectives:

- Develop strategies to transfer and share research and technical information with existing businesses to increase their use of technology.
- Suggest ways for combining resources of government, business and industry, and academia to strengthen research capabilities and establish research centers.
- Develop mechanisms to encourage innovation and support its commercialization in Montana.
- Propose state priorities in scientific and technology areas.
- Suggest ways that education and training can reflect scientific and technology employment needs.

- Develop a strategy to do public- and private-financed cooperative research and development supportive of expanded investment and employment in Montana.
- Determine the appropriateness of research and technology parks.
- Develop a partnership organization, either public or private, to encourage, guide, coordinate and help finance the use of technology and advanced technology economic development.

(3) Subcommittees:

The Council members, at their initial meeting held on October 31 and November 1, 1983, chose to obtain information and ideas from a broad spectrum of people. To accomplish this, informal subcommittees were formed with each subcommittee headed by an Advisory Council member. Nine subcommittees were organized.

- Agriculture Technology, Chair: Pat Iman
- Biotechnology, Chair: Barbara Wright
- Computers, Electronics, and Materials Science, Chair: Robert Swenson*
- Energy and Energy Conservation, Chair: Peter Antonioli
- Financing and Commercialization of Research and Development, Chair: Richard Bourke
- Forestry Technology, Chair: Gareth Moon
- Information Dissemination, Chair: John J. Jutila
- Mineral Technology, Chair: Edward Bingler
- Technical Education, Chair: Leland Walker

*Robert Swenson is a resource person to the Advisory Council.

Nearly 150 people participated in these subcommittees and some 24 meetings were held. A listing of participants is provided in Appendix A. Reports of the subcommittees' findings and proposals were provided to the Council. Summaries of these subcommittee reports are provided in Appendix B.

The major recommendation as well as the other recommendations of the Advisory Council respond to ideas and suggestions developed by the nine subcommittees.

SECTION III

A CHANGING ECONOMY

A. Technology & Economic Development:

The United State economy is changing. The authors of the SRI International report, Economic Revitalization and Technical Change, concluded:

The era of low interest rates, limited foreign competition, stable markets, and production processes that allowed some key industries to operate in a sheltered environment is gone. That environment has been replaced by a world where money has a high cost, international trade is extensive, markets change rapidly, and sweeping development in new technologies make industrial competitiveness a paramount concern.

These authors explain traditional economic development strategies are also changing.

In this new economic environment, efforts to promote the economic development of regions, states, or localities have taken dramatic new forms... Rather than attempting to relocate existing industry from other regions, new revitalization perspectives attempt to create an environment for entrepreneurs to start new firms and apply technology to renew existing industry. Much of the growth of new jobs in today's economy comes from new small and medium-sized businesses that have found ways to serve today's markets in a more competitive manner. In fact, job creation appears to be affected less by the exodus or arrival of large corporations than by the ability of communities or regions to produce and nurture small enterprises.

The creation and growth of a technology-based industry involving the startup and expansion of new enterprises and greater technology utilization by existing businesses is a complex process. Many variables that are beyond the influence of states and local communities are at play: interest rates, money supply, foreign competition and trade, scientific discovery, However, many positive things can be done, including:

- Strengthening research and development capability both by firms and universities to address business and industry needs;
- Helping to develop new enterprises to commercialize new products and processes;
- Transferring applied technology to strengthen existing firms;
- Quality education and retraining of people in modern science and technology;
- Direct research collaboration between industry and academia;
- Investment capital availability and willing risk-taking investors;
- Entrepreneurs willing to undertake the demands of converting science and technology, into business opportunities; and
- A commitment from the government to encourage technology development and economic improvement.

B. Economic Benefits:

Technological change promises many benefits. New ideas, inventions and innovations generate new products resulting in new enterprises and more job opportunities. New production technologies can rebuild and improve lagging productivity of existing firms. For those willing to pursue the

opportunities, technology development and utilization offers significant opportunities for economic growth.

Advanced technology industries are attractive because of their growth potential and ability to generate new employment opportunities faster than conventional industry. Employment in advanced technology grew 20 to 40 percent, depending on definition, over the decade between 1972 and 1982, while overall employment rose by 20 percent, according to the U.S. Bureau of Labor Statistics. This trend is expected to continue through 1995. Two million of the total 25 million jobs created from 1982 to 1995 will be in advanced technology industries (this is 8 to 9 percent of total new jobs). Advanced technology industries are neither the fastest growing employment sector nor will they add the largest absolute number of new jobs. Nevertheless, advanced technology industries will continue to play an important role in job creation and economic development.

Technology development need not overlook existing traditional industries. Older, mature industries can be revitalized through adapting to new markets and becoming more flexible in production to meet changing market demands. The utilization of new technology can benefit all industries and help them become more productive and more competitive at home or with rapidly growing foreign competition.

Advanced technology enterprise can and should be linked to existing firms and operations in the local economy as a supplier of applied technology. Advanced technology enterprise supporting traditional industry provides for more economic development potential.

C. Quality of Life:

Quality of life is important to Montana citizens who have continually sought to protect the environment and the natural amenities that make Montana unique. Additionally, it is becoming clear that meaningful employment opportunities and economic stability are also ingredients needed for a quality lifestyle.

In the 1970's, Montanans adopted a new constitution with provisions for a clean and healthful environment and enacted several significant laws to protect and maintain the state's quality environment. By passing Initiative 95 in 1982, Montanans expressed their desire to use a portion of the Coal Tax Trust Fund for the diversification, strengthening and stabilizing of the Montana economy and to accomplish this while maintaining and improving a clean and healthful environment.

Clearly, quality of life for Montanans means both sustainable, economic prosperity and a healthful, quality environment. Investment that encourages the use of new technology and the development of new technology-based industries offers a brighter economic future. New technology encourages the use of creative skills, knowledge and work ethic of people and has high compatibility with the environment. Additionally, the application of technology can directly improve environmental quality through such activities as pollution abatement, waste reduction, recycling, materials substitution, energy conservation, etc. Also, Montana's quality of life is attractive to many technology-based businesses.

SECTION IV

MAJOR RECOMMENDATION

A PROGRAM FOR INVESTMENT IN TECHNOLOGY DEVELOPMENT

A. Situation:

Dramatic changes in the economic structure of the Nation has led to the displacement of many traditional industries and a growing concern about the future. Montana has been severely affected as well. However, greater application of technology by existing businesses and development of new advanced technology business and industry has the potential to make a positive, long-term contribution to Montana's economic future. The revitalization of traditional industries through the use of technological advances together with the development, expansion and attraction of advanced technology firms, is a major opportunity for new jobs and a more diverse and growing economy.

To bring about economic improvements, however, will require bold new initiatives, which combine the resources of business, industry, education, labor and government. States throughout the nation are anticipating an economy based upon greater technical innovation and more reliance on the value of knowledge-based economic activity; and, they have taken positive steps to respond to this shifting economy.

The members of the Advisory Council on Science and Technology, based on their thorough study of the national situation and public input obtained from subcommittee participants, believe that action must be taken so Montana secures a better economic future and prevents further deterioration.

To achieve results, the efforts and resources of the state must be focused toward those technologies that will benefit traditional industries and have the greatest chance of succeeding and being transferred into positive economic growth in Montana.

B. Technology Enterprise in Montana:

Technology-intensive firms are found in small and large communities throughout Montana. Often they have started or located in Montana because the entrepreneur or principal executive has strong attachments to Montana's way of life and is committed to living here. Existing Montana firms are based on a variety of technologies, including: energy, biotechnology, electronics, information processing, industrial controls, and medical equipment to name a few.

In 1984, over 11,000 Montanans were employed in technology-intensive industries. About 14 percent of all manufacturing jobs were in technology-based firms. Overall, technology-intensive employment in 1984 represented about 5 percent of total non-farm employment in the state. Several technology-based firms are among the faster growing enterprises in Montana. See Appendix E for details about technology-intensive sectors in Montana's economy.

C. Recommendation:

(1) Create a Science and Technology Development Investment Program:

The Advisory Council's major recommendation is the creation of a Science and Technology Board and Alliance. The Alliance's mission would be to improve the state's economy by investing in public and private programs and projects assisting and supporting technology use and development in Montana. Investments would help existing businesses obtain, use and benefit from new technological advances, and would make the state more desirable and competitive as a location for technology-based businesses.

The Alliance for Science and Technology Development would have major responsibilities in the following areas:

- a. Administer the Montana Science and Technology Development Fund with four investment programs:
 - research capability investments, including establishing University research faculty chairs;
 - matching research investments;
 - technical assistance/transfer investments, including creation of a private, non-profit Telecommunication Corporation;
 - seed capital financial support program.
- b. Provide services to existing businesses in Montana including:
 - assure, in cooperation with others, that information related to new technology, research and development, manufacturing

- and financing is accessible to Montana businesses, research organizations, researchers, research projects and others;
- inventory existing technical and scientific data base services and provide instructions on how to gain access to those services. Investigate opportunities for expanded opportunities in this area;
 - encourage and sponsor, in cooperation with other private and public organizations, conference, symposia and trade shows of interest to firms, entrepreneurs and financial institutions;
 - provide assistance to firms wishing to obtain grants from the Federal Small Business Innovations Research (SBIR) programs, and
 - provide other assistance as necessary to encourage innovation and business development.

D. Targeted Technologies:

The Council recommends the following technologies as the focus for investment by the proposed Alliance for Science and Technology Development. Further refinement of these technologies will be necessary. However, to provide flexibility, all technologies (both those existing and as yet unknown), not just targeted technologies, shall be eligible for Alliance support.

(1) Mineral Technology:

Montana's abundant natural mineral resources face increasingly stiff foreign competition and high transportation costs. Among the goals identified as crucial to making mineral resources competitive are:

- a. Coal characterization and processing;
- b. Improvement in efficiency of oil and gas extraction;
- c. Improvement in mineral concentration technologies;
- d. Improvement in mineral exploration technologies; and
- e. Other.

(2) Agricultural Technology:

Montana produces an abundance of agricultural products, over 50 percent of which must compete in an uncertain world market. The remainder must compete on a domestic market with products that are grown where shipping costs are lower and/or production unit costs are also lower. Additionally, on the national scene, fewer producers are needed to supply necessary food and fiber. To overcome the disadvantages inherent in these conditions, research and technological development must focus on:

- a. Developing product processing facilities in the state;
- b. Conducting more product development;
- c. Providing necessary expertise to Montana entrepreneurs seeking to establish enterprises based on increased utilization and/or value enhancement of agricultural products; and
- d. Other.

(3) Forestry Technology:

The keys to maintaining and improving the economic return from forest resources are:

- a. Enhancing growth and utilization processes;
- b. Better utilization, management, and protection of second growth forests;
- c. Intensifying cellulose product development and wood chemistry research;
- d. Improving and creating new harvesting technologies;
- e. Establishing a firm multiple-use land base to support forest industries while maintaining essential wildland and urban areas important to all Montanans; and
- f. Other.

(4) Biotechnology:

A common thread that winds through many of the other technologies (agriculture, forestry, mineral, energy) is the use of . . . biotechnology. The goals identified with particular relevance to Montana are:

- a. Genetic engineering of plants and animals;
- b. Immunology;
- c. Toxic water treatment;
- d. Mineral recovery;
- e. Synthesis of new chemical products; and
- f. Other.

(5) Microelectronics and Computer Sciences:

Electronics and computer technologies have had a profound impact on our society. Translating those benefits into Montana's economic system means work is necessary on the following:

- a. Robotics;
- b. Computer-aided design and engineering (CAD/CAE);
- c. Fiber optics and laser development;
- d. Communication technology;
- e. Applications of computer technologies to Montana businesses;
- f. Other.

(6) Energy Technology:

Montana's abundant energy resources require careful development to meet the expectations of Montanans for jobs, economic development and environmental protection. To enhance the utilization of these energy resources in a manner compatible with the concerns of the citizens, the following areas require research work:

- a. Improvement in coal utilization (liquefaction, gasification, MHD and fluidized bed);
- b. Energy conservation technologies improvements;
- c. Development of renewable resource potentials;
- d. Other.

(7) Information Sciences:

The transfer of scientific, technical and business information to the businesses and industries of Montana is crucial for firms to remain competitive. The specific work areas identified are:

- a. Creation of adequate data bases specific to Montana;
- b. Access to existing data bases;
- c. Applications of computer software to Montana businesses;
- d. Other.

(8) Materials Science:

Advances in all technologies will call for new and more sophisticated materials and their uses, whether it be stronger and lighter materials for construction or smaller and faster electronic materials. The economic competitiveness of many technologies will hinge on the availability of novel materials. Of all sciences, the time from discovery to product development is the shortest in the materials area. Because of some existing research facilities and personnel in the state, Montana is in a position to develop some unique programs with wide ranging impacts. Based on present strengths, key areas identified as opportunities for Montana are:

- a. Composite structures, layered materials and interfaces;
- b. Alloys and semiconductors, thin films, laser materials;
- c. Surface modifications, catalysis, corrosion;
- d. Electrically active polymers;
- e. Ceramics;
- f. Others.

These targeting technologies will help initially focus the investment agenda for the proposed Alliance on those areas believed to have the highest potential to enhance growth in Montana.

E. Operation:

The proposed Montana Alliance for Science and Technology Development would make investments to public and private organizations to: (1) support cooperative private/public research and development which would have economic significance, (2) strengthen the state's research and development capability; (3) help Montana businesses and industries utilize new technology in their operations, and (4) provide seed capital financing, through financial intermediaries, to entrepreneurs and investors doing early stage development work leading to new commercial products or new business start-ups.

Investments would be used to encourage and leverage financial support by providing matching funds for Montana projects proposed by other entities (private and public) and individuals to promote in-state technological development and use. Supported business and industrial enterprise must maintain, or propose to maintain, a relevant research, development or manufacturing facility in the state, or propose to form research and development joint ventures with in-state research and develop organizations. It is expected that the investment program can achieve a 60/40 matching ratio of state funds to private and other public sectors' funds.

Investments would support programs and projects that would benefit various existing sectors of the state's economy (minerals, agriculture, forestry, energy, retailing and small manufacturing) as well as expanding and diversifying the economy by supporting emerging technologies (micro-electronics, computers, biotechnology, materials science,

information sciences). Other technology areas would also be eligible. All investments would be selected on a competitive basis with the proposed Science and Technology Board having final selection authority.

F. Funding:

Alliance investment programs would require funding from the legislature. The Advisory Council recommends that the Coal Tax Trust Fund (\$6 million per year for 10 years, or \$60 million total) be used. State funding would cease after 10 years and the Alliance could then operate from interest on the remaining principal and from royalty and license income derived from investments and intellectual properties held. The Alliance would maintain a limited royalty position on security interest in intellectual property rights in supported research and development as necessary to fulfill fiduciary responsibilities of the Fund. Also, equity investments would be made, through financial intermediaries, in start-up companies. Not every investment will be successful and produce income. Because of the matching requirement of key investment programs, the total state investment of \$60 million should leverage an additional \$40 million of private sector and other public monies.

G. Administration:

A proposed 15-member Board of Science and Technology, appointed by the Governor for staggered four-year terms, would administer the Alliance. Eleven members would be from the private sector. Assisting the Board would be an Executive Director with minimal staff. The Board, the Executive Director, and the staff, as an administrative unit, would be known as the Montana Alliance for Science and Technology Development.

Figure 1 on the following page shows the organizational structure of the proposed Alliance.

H. Investment Programs:

The Montana Alliance for Science and Technology Development would have four complementary investment programs. These programs would leverage additional private and public investment through matching requirements and preferences.

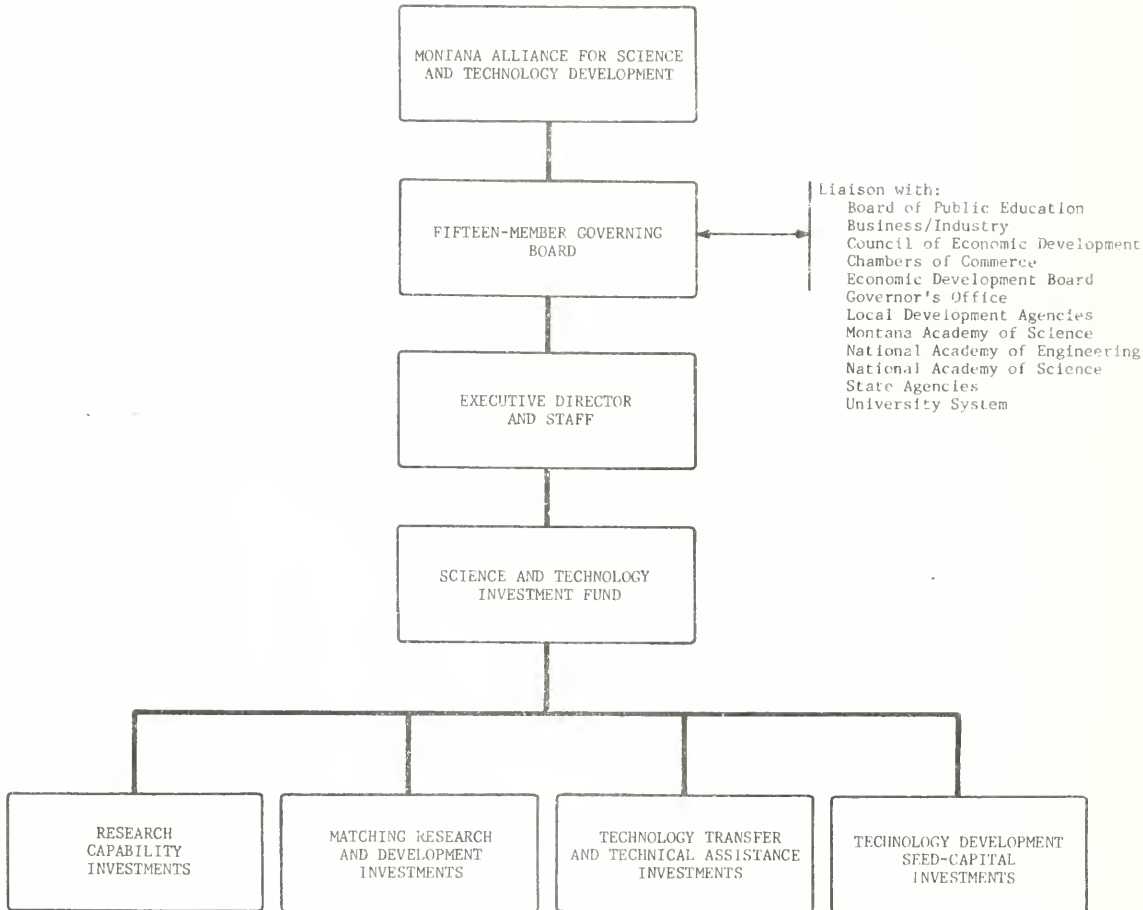
(1) Matching Research Investments:

Purpose: The Alliance would jointly invest in sponsored product development projects proposed by industry, universities, colleges and other appropriate research and development organizations. Investments would be for those development projects leading to a product or process intended for commercialization and production in Montana. Proposals should be based on innovative ideas, the commercial application of which could result in products and processes for manufacture and sale. Royalty incomes and license fees from the fund's share of investment would accrue to the fund. Funds could be used to match Federal Small Business Innovation Research (SBIR) grants received by small businesses in Montana.

Matching: The Alliance would expect a match of a dollar for each Alliance dollar invested (100 percent). In-kind or equipment use in the project could be part of the expected match.

FIGURE 1

PROPOSED STRUCTURE OF THE MONTANA
ALLIANCE FOR SCIENCE AND TECHNOLOGY DEVELOPMENT



Eligibility: Montana industry and business, universities and colleges, research organizations.

Priority: Priority would be given to research and development projects that are joint partnership efforts between industry and university system units.

(2) Research Capability Investments:

Purpose: This program would make investments to create or strengthen applied research and development capabilities in the state in areas having significant potential to support business and economic development. Investments would be for establishing applied research centers, staff, equipment, and operating costs; however, the construction of buildings or structures would not be eligible for investment. Research capability investments would be of fixed duration and would not duplicate existing research and development capability in the state.

Matching: The fund would give preference to investments that obtain at least a match of fifty cents for each fund dollar invested (50 percent). In-kind or equipment use may be part of the match.

Eligibility: Any legitimate research and development entity maintaining or proposing to maintain a facility in the state.

Priority: Priority would be given for capability investments supporting partnerships or consortiums between Montana business and industry and the university system units.

(3) Technology Assistance and Transfer Investments:

Purpose: This program would invest in programs providing training, assistance and information helping new and established firms develop and utilize technology to improve productivity and profitability. Investments will support programs providing, among other things, technical and commercialization assistance, technological training, and access to technical and business information sources. For example, Computer Aided Design/Computer Aided Manufacturing technology (CAD/CAM) can be used by Montana's small manufacturers to increase productivity; the transfer of this advanced manufacturing technology to Montana small businesses is a type of program envisioned.

Matching: The fund would give preference to investments that obtain some level of matching. In-kind or equipment use may be part of the match.

Eligibility: Any private or public Montana organization.

Priority: Priority would be given to investments in programs representing partnership efforts between business and industry, university units, and state and local governments.

(4) Seed Capital Financial Investments:

Purpose This program would provide financial support to leverage private sector seed capital formation (early stage financing) for joint investment in businesses and projects at the early stages of the innovation process leading to a commercial application.

Investments would be made through financial intermediaries with money-at-risk in business start-up and development projects at stages (b) through (d) of the development process shown below:

- (a) Idea
- (b) Proof-of-concept
- (c) Prototype development
- (d) Product development
- (e) Commercial application

Early-stage financing has a high degree of risk but carries with it the potential for a large return on investment. Money for this type of investment is in short supply in Montana. Entrepreneurs, therefore, go out of state for investment or abandon their ideas; thereby, limiting or restricting entrepreneurship based on innovation.

Financial investments would be provided to applicants in participation with financial intermediaries who have their own money at risk. These financial intermediaries would include, but not be limited to: Montana Capital Companies, Montana-based Small Business Investment Corporations (SBICs), and Research and Development Limited Partnerships.

Investments from this program could be used to leverage equity investments in Montana small businesses who, because of Federal SBIR awards, have products to commercialize.

The Montana Economic Development Board because of its financial expertise would administer this program for the proposed Montana Alliance for Science and Technology Development under program objectives and criteria developed by the Alliance.

Royalty incomes and license fees from the Alliance's share of investment would accrue to the Science and Technology Development Fund.

Matching: Financial investment will be considered only if a financial intermediary has equal dollars-at-risk.

Eligibility: Montana Capital Companies, Montana-based Small Business Investment Corporation (SBICs), and Research and Development Limited Partnerships with proposed investments in promising Montana business start-ups and R & D projects.

I. Criteria for Investment:

Three principal criteria would be used in selecting investments: 1) quality of scientific work and commercial success as determined by peer review and business management review; 2) likely contribution to improving the state's economic well-being and creation of jobs, and 3) no duplication of existing facilities, or ongoing programs, projects, services or work.

J. Annual Budget:

The estimated annual budget for the proposed Montana Alliance for Science and Technology Development is shown in Table 1 on the following page.

K. Implementation and Funding:

The creation of a Montana Alliance for Science and Technology Development, its Board and investment fund requires legislation. It is proposed that the Alliance for Science and Technology Development be funded from the Coal Tax Trust Fund and be appropriated at the rate of \$6 million annually for 10 consecutive years for a total of \$60 million. The Science and Technology Development Fund could, after 10 years, become self-sufficient, operating from interest on principal and from accruing royalty and license income, or it could cease operation.

The Coal Tax Trust Fund is an appropriate source of funds for technology investment. Citizens of Montana, in passing Initiative 95 in 1982, declared that a primary purpose of the Coal Tax Trust Fund is to develop a stable, strong, and diversified economy for present and future Montana residents while maintaining a clean and healthful environment. They further declared that investment objectives of the Coal Tax Trust Fund are to diversify, strengthen and stabilize the Montana economy and to increase Montana employment and business opportunities. Investments in technology development would meet these objectives and criteria.

TABLE 1

MONTANA ALLIANCE FOR SCIENCE & TECHNOLOGY DEVELOPMENT
ANNUAL PROGRAM BUDGET

Item	Purpose	State Funds	Estimated Matching
<u>Programs:</u>			
Matching Research Investments	To match business & industry funds committed to research & development (R&D) having high potential to support existing business & industry.	\$2.00 MM	\$2.00 MM
Research Capability Investments	To strengthen or create research & development capabilities in areas of potential economic significance.	\$2.50 MM	\$1.25 MM
Technology Transfer & Assistance Investments	To establish & strengthen programs providing technology transfer & technical assistance to Montana business & industry.	\$0.50 MM	---
Seed Capital Finance Investments	To provide, through intermediary financial institutions, early-stage financing. Program to be administered by the Economic Development Board.	\$0.75 MM	\$0.75 MM
Subtotals:		\$5.75 MM	\$4.00 MM
<u>Board & Staff Salaries, Expenses, & Operations:</u>	To provide administrative funds for the Board & staff operation to include policy development, technical assistance, communications, and information services.	\$0.25 MM	
TOTALS:		\$6.00 MM	\$4.00 MM

SECTION V

OTHER RECOMMENDATIONS

A. University System Budget Modifications:

(1) Situation:

The units of the University System will submit to the Legislature program budget modifications for the 1987 biennium. These budget modifications support areas of interest to the Advisory Council including appropriate research related to economic development, technical and business assistance to business, agriculture producers and government, and an expanded graduate program in business administration.

(2) Recommendation:

The Advisory Council recommends that the Legislature support the University System program modifications (see Appendix D), which can significantly contribute to long-term economic development.

(3) Potential Economic Development Impact and Other Related Impacts:

The University System units will play a major role in the economic future of Montana. The use of knowledge, the diffusion and application of technology, and the stimulation of innovation have large potential for improving business productivity and competitiveness. Therefore, Montana businesses will depend even

more on university units graduating quality students in business, engineering and sciences, and having first-rate research and business assistance programs essential for the support and growth of existing traditional industries and advanced technology industries.

(4) Implementation:

The Montana Legislature is responsible for funding these programs while the University System and its units are responsible for implementation and administration of the program.

B. Research Chairs to Support Cooperative Research:

(1) Situation

A need exists to immediately strengthen Montana's capability in support of advanced technology economic development. Strong University System applied research expertise, working collaboratively with industry, is widely recognized as a key determinant in supporting existing industries and in the start-up and location of advanced technology firms. To obtain quality research expertise, the establishment of research chairs with competitive salaries is needed to support Montana business and industry.

(2) Recommendation:

The Advisory Council recommends the establishment within the University System a program of seven distinguished applied research chairs to support the product development needs of existing Montana industries as well as new technology-oriented industries.

(3) Potential Economic Development Impact:

An infusion of nationally recognized scientific expertise into Montana's University System would be a major commitment to strengthening Montana's position in promoting technology. This added expertise would be applied to strengthen R & D capabilities and encourage the development of advanced technology industry in the state.

(4) Implementation:

The Board of Regents and units of the Montana University System would implement the program. Research positions created and expertise sought to be decided by each participating unit with advice and guidance from representatives of the private sector and the proposed Science and Technology Development Board. Positions would be created in technology areas targeted by the proposed Board.

Estimated cost is \$700,000 annually (\$100,000 for each chair).

Industrial and business matching financial support of the program is expected. The establishment of applied research chairs is proposed to be funded from the Alliance's research capability investment program.

C. Commercialization of University Research:

(1) Situation:

The University of Montana (UM) and Montana State University (MSU) are the two units of the University System that have some formal

licensing program and procedures for commercializing marketable products or processes resulting from university research.

When a new product or concept with commercial potential is developed, UM either contracts with the Research Corporation, with offices in New York and Tucson, Arizona, or chooses to handle the patenting/licensing internally through the Office of the Vice President for Research. The Research Corporation is contacted if the commercialization potential is particularly large, has the potential for litigation, or marketing is problematic. The Research Corporation has been approached by UM three times in the last five years and in each case has turned down the proposed product/concept.

MSU has organized the Research and Development Institute (RDI), a private non-profit corporation, whose objective is to provide support for the research mission and assist MSU personnel in licensing and commercializing products and concepts developed by them. RDI provides MSU with more control over the commercialization process. MSU had, in the past, retained the services of Research Corporation but considered the general level of service inadequate. RDI's Board of Directors consists of MSU personnel. It has no permanent staff; however, part-time legal services are acquired on an "as needed" basis.

No formal, system-wide policy exists within the University System to encourage commercialization of university research in Montana, which would encourage entrepreneurial involvement by Montana businesses.

A subcommittee of the Advisory Council on Science and Technology concluded (a) that more University System resources and funding must be devoted to commercializing university-related research; (b) that a more formal and aggressive University System approach to research commercialization is needed, and (c) that Montana businesses should have the first opportunity for commercializing marketable University System research.

(2) Recommendation:

The University System is encouraged to: (1) critically examine existing patenting, licensing and commercialization services and develop enhanced and more efficient means to provide these services within the entire University System; (2) increase university support for patenting, licensing and commercialization services; and (3) develop a systemwide policy requiring investigation of the opportunity and feasibility of licensing and commercializing university technology by Montana firms or Montana-based firms prior to contacting out-of-state firms. The policy should include a formal communications system to share the University System's product developments and other commercialization opportunities with Montana's financial and business community and to obtain from the Montana business community ideas for additional applied research and product development.

(3) Potential Economic Development Impact:

University System research has brought several significant new technologies into the private sector. More new commercial

technologies and products are possible if university research capabilities are enhanced and utilized in partnership with business and industry. These partnerships would be supported by the programs of the proposed Montana Alliance for Science and Technology Development. Transferring new technologies and discoveries to Montana firms for their production and use can strengthen and diversify the economy of the state. Any one unique discovery or innovation has the potential for rapid growth and job creation.

(4) Implementation:

The University System and its units would be responsible for implementing the recommended commercialization policies and procedures.

D. Science & Technical Education:

(1) Situation:

With major shifts in our economy to more reliance on scientific and technical knowledge, it is important that citizens receive the training to provide skills needed by industries utilizing and managing new advances in technology. In addition, the schools (K-12, vo-tech, colleges and universities) can strive to develop interest in technical and scientific careers and enhance overall scientific and technical literacy among all students. Adult education and other means can be used to improve the understanding of technology of the general public.

(2) Recommendation:

a. Teacher Training:

Those institutions training secondary teachers should examine and strengthen, where appropriate, those elements which would enhance the preparation for teaching science, mathematics and computer-related programs. At the same time, summer and/or continuing education programs for re-training present teachers in those areas, should be developed.

b. Vocational Education:

Support the development of vocational-training curricula which reflects emerging employment opportunities. The vo-tech schools and community colleges should be strongly encouraged to develop the systems and procedures which will permit them to quickly respond to identified, specific skill training requirements.

c. Skills Development:

Support greater emphasis on mathematics, science, computer literacy, communication skills and entrepreneurship for technology-oriented programs in all grade and education levels.

d. Industrial Involvement and Support:

Support development of programs whereby industry can interact regularly with grade and high school officials to improve and expand mathematics, science and technology education, strengthen the competence of teachers, and provide advanced technological equipment and facilities.

e. Career Opportunities:

Support programs that identify and familiarize students with career opportunities that are available as a result of new technological advances.

f. Information Networks:

The proposal of the information dissemination subcommittee to develop a statewide communications network for data access and delivery of continuing education offerings is strongly supported. In addition, support must be provided for the development of these program offerings.

g. Continuing Education:

Support expanding continuing education, evening programs, and other opportunities to serve adults seeking to upgrade, retrain, or become generally more knowledgeable about new technology. The Board of Public Education and the Board of Regents should be encouraged to develop both programs and courses to enhance the understanding of science and technology in human affairs, both at secondary and post-secondary levels.

h. Opportunities for Women and Minorities:

Women and minorities are underrepresented in science and engineering positions and represent an untapped pool of talent. Women and minorities should be given greater access to scientific and technical education, training, and careers and more self-employment opportunities in technical areas.

(3) Potential Economic Development Impact and Other Related Impacts:

Having a supply of well-educated students and trained workers is a prerequisite for advanced technology utilization and innovation by traditional and emerging industries. Strong education and training programs help assure that local students and workers can compete for technical positions.

(4) Implementation:

Board of Regents, Board of Public Education, Office of Public Instruction, university and college administrators and faculty, school boards, school administrators, and teachers.

E. Research/Technology Parks & Technology-Based New Business Incubator Facilities:

(1) Situation:

Research/Technology parks designed specifically for advanced technology research, development, and light manufacturing are proliferating and are becoming key factors in creating a commercial climate conducive to the start-up and siting of new technology enterprise. Currently, no science or research and development parks exist in Montana that are specifically directed toward firms doing science and advanced technology development. This situation hinders development in Montana and will continue to do so unless remedied. Having research/technology parks in Montana in appropriate settings (particularly near universities and colleges) is a necessary component to increase technology development in Montana.

Technology-based business incubator facilities (organizations created to nurture the start-up of new firms by providing, at reasonable costs, space and various shared business support and technical services) are being established outside of Montana to encourage the creation and successful initial operation of technology-based firms. Presently no incubator facilities exist in the state. Clearly, this restricts the opportunity to create new businesses and associated employment opportunities in Montana.

Two of the Council's subcommittees have identified research/technology parks and technology-based, small business incubator facilities as possible methods to encourage technology-based business development.

(2) Recommendation:

The proposed Alliance for Science and Technology Development and the Department of Commerce should work with the private sector, local development corporations, federal laboratories and the University System to evaluate the feasibility of research/technology parks and technology-based, small business incubator facilities as methods to encourage technology-based business development. Investments from the proposed Alliance should be made available for feasibility studies and initial planning of possible research/technology parks and technology-based, small business incubators.

(3) Potential Economic Development Impact:

High quality, research/technology park developments offer a variety of advantages to start-up and established firms. They can provide

the environment and location, with appropriate services and buildings, being sought by desirable companies. These technology-based companies offer high growth potential, require skilled and educated workers, have minimal impacts and create a need for support services provided by local businesses and universities. Research/technology parks can be a magnet for locating new and expanding firms and supporting businesses.

Technology-based, small business incubators can help entrepreneurs starting firms overcome the critical problems of finding affordable space and obtaining support services. New businesses are more likely to succeed and become established in local communities if these services are available.

(4) Implementation:

The proposed Montana Alliance for Science and Technology Development, the Department of Commerce, local governments, the University System, federal laboratories and the private sector should work to establish procedures and methods to determine feasibility and assist in the creation of research/technology parks and technology-based, small business incubator facilities in appropriate locations.

F. Telecommunication Corporation:

(1) Situation:

Ready access to information, services and rapid communication is crucial to a thriving economy. In a large rural state like Montana,

innovative uses of telecommunications (interactive voice, data, facsimile and video) can substitute for traveling. Montana has significant training and educational resources; but better access to these resources, particularly for people in remote areas, is possible. Additionally, Montana has a variety of information dissemination facilities and telecommunications systems that can be coordinated to the advantage of both the public and private sectors. A need exists for a comprehensive inventory; and the planning, coordination, aggregation and pooling of available telecommunications and informational resources, both public and private, into an efficient, modern system.

(2) Recommendation:

An integrated statewide telecommunications system is needed to provide a cost-effective means of electronic networking for public services, dissemination and private access to public resources. To do this a working partnership between public and private telecommunications entities in the state should be established. A Committee of the Science and Technology Development Board should be formed to plan, develop and launch a private, non-profit corporation to provide telecommunication services to the people of the state.

(3) Potential Economic Development Impact:

An efficient statewide system of electronic networking would serve as a catalyst for economic development by providing timely access to necessary information and expertise. A partnership of government, private industry and educational interests in the state (under the

guise initially of the proposed Committee, and ultimately under the resultant non-profit Corporation) could provide the organizational and financial mechanism needed to realize state-of-the-art telecommunications facilities, by utilizing leasing arrangements as well as private upfront capital investment, and by aggregating users and sharing facilities.

(4) Implementation:

The proposed Science and Technology Development Board would appoint a Telecommunications Committee to function for a period of two years. The Committee would be comprised of representatives of state government, educational interests, private industry and the general public with expertise and interest in telecommunications and information dissemination. The Committee would pursue two major activities: (a) in conjunction with the state Communication Division, plan the development of an efficient telecommunication system; and (b) create a non-profit corporation to coordinate the utilization of existing telecommunication systems as well as provide a means of developing new telecommunications capabilities. The Committee would design and implement the proposed corporation.

(5) Cost:

Two hundred thousand dollars (\$200,000) is needed to administer a telecommunication committee and to support the committee's effort to launch a private, non-profit corporation. Funding for the subcommittee should be an investment from the Alliance's Technology Transfer and Technical Assistance Program.

APPENDICES

- A. SUBCOMMITTEE PARTICIPANTS
- B. SUMMARY OF SUBCOMMITTEE REPORTS
- C. INITIATIVES OF STATE GOVERNMENTS
- D. UNIVERSITY SYSTEM BUDGET MODIFICATIONS
- E. TECHNOLOGY-INTENSIVE SECTORS IN MONTANA'S ECONOMY

APPENDIX A

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APPENDIX B

ADVISORY COUNCIL ON SCIENCE AND TECHNOLOGY SUMMARY OF SUBCOMMITTEE REPORTS OCTOBER 1984

AGRICULTURE TECHNOLOGY

The subcommittee proposes to strengthen agriculture research. Scientists are available to carry out an expanded research program in new areas; but additional funds are needed for operations, personnel, and capital investments.

A Board of Science and Technology is proposed to provide grants to support research and technological advances. Also, University scientists working on agricultural related research at MSU have discoveries that have commercial application. Having no entity in the state designed to move research projects to the market place is a problem. Montana needs a single entity to coordinate research and development, and available funds to help move new innovation to the market place.

Also, proposed is a program to find more ways to utilize Montana's agricultural products and/or enhance the products before they are exported from the state. Developing industries that will refine the agriculture products would improve the agriculture economy and provide jobs for more Montana people.

BIOTECHNOLOGY SUBCOMMITTEE

This report consists of three recommendations. The first one is to establish a permanent Board of Science and Technology. It would be responsible for conferences, trade shows, directories, patenting procedures, a grants program, and encourage the establishment of new business.

The second recommendation is to establish a Biotechnology Center and incubator facilities. Details on the kind of facilities needed would be left to a permanent Board of Science and Technology. The needs of new research capabilities or an administrative center for fostering the exchange of biotechnology information between industry and the academic community will be considered.

The third recommendation is to have the state sponsor R&D limited partnerships for funding technology to where it becomes a revenue-producing activity. The committee believes state sponsorship would address the serious capital shortage problem. The stage of R&D in most need of financial help is between the idea or patent and the point where it is clear that the business will become commercially viable. State funds are needed for this stage of R&D and can be used to match funds from private investors.

SUBCOMMITTEE ON COMPUTERS, ELECTRONICS,
AND MATERIALS SCIENCE

The subcommittee's report consists of ten recommendations.

1. Establish a program for the coordination, access, and dissemination of information, data, activities, facilities, expertise, etc. There is a need to provide awareness of available programs and technology data bases.

2. Establish entities whose purpose is to move basic research ideas towards commercialization. These entities should facilitate the interactions among industry, business, government, and universities. Focus should be on technology transfer, extension, and product development.

3. The state should support non-directed research in areas of strength in the university system, particularly those relevant to future technologies.

4. The state should establish one or more "Technology Research Centers", and that one of these centers be established at Montana State University in the area of Advanced Materials Synthesis and Characterization.

5. It is necessary to develop physical facilities to meet the expanding role the universities will play in a "Build Montana" program. The universities do not have adequate space for their own programs let alone for additional activities.

6. The state must foster, promote, and support the concept of lifetime learning. There is need for continuing education, particularly in the hi-tech businesses which must maintain a competitive edge. Perhaps tax incentives for businesses and additional funding for universities will be necessary to encourage this activity.

7. Active, aggressive, educational and public relations programs to change attitudes towards doing high technology in the state of Montana need to be undertaken. All citizens need technology awareness to encourage technological evolution in the state.

8. The Council should promote meetings of interested parties throughout the state relating to questions of computers, computing, and computer science. An unhealthy competition and a lack of interaction among the units of the university system seems to exist, particularly in computer course offerings and degree programs in computer science. The next generation of mainframe computers should be located at one point in the state with access from university, government, and business.

9. A Montana electronics and computer trade booth should be prepared by the Department of Commerce to send to the trade shows around the country. In addition, the Department of Commerce should sponsor an in-state conference of all parties interested in computers and electronics. A possible outgrowth of such a conference would be a Montana-based trade show.

10. University researchers must be provided with more flexibility and incentive in obtaining reimbursement from activities on research projects. The present summer salary restrictions is a serious impediment to keeping faculty on campus working on projects of interest to industry.

ENERGY AND ENERGY CONSERVATION SUBCOMMITTEE

It is the recommendation of this committee that the resources of the state be directed toward developing the research and technology base of our natural resource industries as they are related to energy and energy conservation.

To accomplish this, the subcommittee recommends the establishment of a research and development agency to foster and initiate research and development activities in those areas that are critical to encouraging economic growth in the field of energy production, energy conservation and renewable resource development.

The agency would receive a budget from \$2 million to \$5 million per year to carry out its R&D goals. This budget should consist of as much private funding as possible with the balance from the State. Another approach might be for matching state government funds (50% by the private sector, 50% by government) with the benefits being jobs and opportunities in Montana.

Following formation of an appointed Council on Science and Technology, some preliminary R&D goals recommended by this subcommittee for consideration by the Council and the "Agency" are as follows.

Methods must be explored that seek to reduce the costs of transportation for the carbonaceous fuels in Montana. Among the recommendations for investigation are: coal beneficiation, coal liquification, methods of acceptable coal slurry transportation, production of synthetic fuels and coke, drying and pelletizing of lignite, and reduction of mineral content of coal.

Additionally, expansion of research into other areas of increased coal utilization efficiency with minimal environmental impact is recommended. These include: commercialization of MHD technology, acid rain reduction technologies through increased scrubber efficiencies, and clean, small coal combustors for residential use.

The recommendations for oil and gas R&D are investigations into: development of oil shale, recovery of oil and gas from non-conventional sources, cogeneration systems to efficiently utilize oil and gas resources, and enhanced recovery systems for oil and gas.

With the vast renewable resource potential of the state, the subcommittee recommends that renewable resource investigations and development become a keystone in the development of the energy systems in Montana.

Methods and mechanisms must be found to reduce the cost of transportation of our products to market.

Additional research is needed into: uniform building codes to insure they are as energy efficient as possible based on future energy prices, and cost effective superinsulation techniques for existing structures.

FINANCING AND COMMERCIALIZATION OF RESEARCH AND DEVELOPMENT SUBCOMMITTEE

The subcommittee made four basic recommendations.

1. Encouragement for the University System to increase support for patenting, licensing, and commercialization services. A formal communication link should be established between University commercialization services and Montana's financial and business community designed to share information about University patenting and licensing activities.

2. A program should be implemented to invest either Board of Investment funds or Montana Economic Development Board funds in Montana Capital Companies or Montana-based SBIC's under terms allowing for use of these funds in early-stage financings. Also, the legal issues concerning fiduciary responsibilities of these Boards should be studied.

3. Establishment of financial incentives for the private sector or local economic development entities, to establish and operate no more than three incubator facilities.

4. Analysis of Montana R&D investment tax laws to identify differences between Montana laws and those in other Rocky Mountain states and for consistency with federal laws.

FORESTRY SUBCOMMITTEE

Montana's business climate for forestry-related activities is deteriorating. The cost of doing business in Montana is higher than competitive states because of transportation costs, taxes, environmental regulations, etc. A better analysis of forest management costs and values is needed. More information is needed on the supply and long-term potential productivity of wood, water, wildlife, forage and recreation on all lands. Improved multiple-use management strategies need to be developed and more economic harvesting and utilization systems are needed.

Four recommendations were made by the subcommittee:

1. The State's mission-oriented forestry research program is centered at Lubrecht Experimental Forest. Expansion of this research program is essential to develop improved technologies for resource management and the wood products industry. The State needs to encourage federal and private research support to promote stable cooperative solutions to priority resource management problems.

2. Timber resource supplies must be identified and projected to enable land managers to develop long-range plans.

3. A standardized mechanism to communicate research results, legislation, and other important information must be developed and implemented.

4. Steps are needed to create a more favorable business climate through appropriate legislation, favorable tax structure, and promotion of resource-related assets.

INFORMATION DISSEMINATION SUBCOMMITTEE

A general statewide needs assessment was conducted by the Cooperative Extension Service and it was determined that over half of the problem-solving recommendations, particularly those concerning access to information, could be accomplished through telecommunications applications. The primary need appears to be not in developing new information resources but; rather, better access to the existing resources.

Two proposals were submitted by this subcommittee.

1. A statewide science and technology information service needs to be created to facilitate technology, transfer and promote economic development by providing access and referral to key sources of information and services. The state should provide a clearinghouse for information services and research resources available in the state as well as nationally. A central office should be designated to act as an information consumer advocate and referral service. The office should also act as an advocate for further development of information services and systems.

2. An integrated statewide telecommunications system should be developed to provide a cost-effective means of electronic networking for public services dissemination and access to public resources. The state should lead the planning, development and implementation of such a system but it should do so in a partnership forum with the telecommunications industry.

SUBCOMMITTEE ON MINERAL TECHNOLOGY

The mineral industry, which includes coal, metals, nonmetals, oil, and gas, contributes significantly to the economy of the State of Montana through tax revenues and jobs, and indirectly through the growth of local businesses. Many complex issues are associated with the industry. For example, a number of economic factors, such as capital costs and commodity pricing, influence the viability of a project. Technology plays a crucial role in exploration, extraction, and production of a particular mineral; and research and development in areas like geophysics and geochemical techniques aids in mineral discovery.

Because the mineral industry is so important to Montana, state and private sector partnerships must be formed to design and carry out new programs in response to the industry's needs. The Subcommittee on Mineral Technology has outlined several policy goals for adoption by the Governor's Council on Science and Technology, and has specifically identified program initiatives that could be undertaken through public/private sector cost sharing.

The minerals industry offers the state the opportunity for continued economic growth. In order to strengthen the mineral industry in Montana and ensure its future, the state must invest in the scientific and technological development needed to enhance our regional mineral industry.

SUBCOMMITTEE ON TECHNICAL EDUCATION

Montana's present educational infrastructure includes provision for the "traditional" range of training for science and technology fields:

1. Preparation for career training (K-12).
 - Recent actions of the Board of Regents, Board of Public Education, and some local School Districts have resulted in improvements.
2. College - University career training.
 - There is a good distribution and coverage of the traditional fields, as well as mathematics, computer-related programs, and businesses.
3. Vo-Tech Skill training.

It is the non-traditional types of education and training, continuing education, and re-training, where there is an unmet demand, now, and even greater demand expected in the future.

There is a general shortage of qualified, secondary level mathematics, computer and science instructors. Further, many now teaching these subjects may need to be up-dated to present-day "state-of-the-art". Recent actions by the Board of Regents and the Board of Public Education may hasten response to these concerns.

A related concern of the subcommittee is having a reasonable level of science and technological literacy among the citizens of Montana. This comes from a recognition that informed governmental and business decision making is only possible if the decision-makers have a grounding in the basic fundamentals of science and technology.

The subcommittee made four general recommendations.

1. Those institutions training secondary teachers should enhance the preparation for teaching science, mathematics and computer-related programs. At the same time, retraining for present teachers in those areas should be developed.

2. The proposal of the information dissemination subcommittee to develop a statewide communications network for data access and delivery of continuing education offerings is strongly supported. In addition, support must be provided for the development of these program offerings.

3. The Vo-Tech schools and Community Colleges should develop the systems and procedures which will permit them to quickly respond to identified, specific skill training requirements.

4. The Board of Public Education and the Board of Regents should develop programs and courses which enhance an understanding of science and technology in human affairs at secondary and post-secondary levels.

APPENDIX C

MONTANA ADVISORY COUNCIL ON SCIENCE AND TECHNOLOGY

INITIATIVES OF STATE GOVERNMENTS FOR TECHNOLOGY-BASED ECONOMIC DEVELOPMENT: AN OVERVIEW December 1984

Introduction:

The National Governors' Association (NCA) Task Force on Technological Innovation observed that:

"State governments are critically situated to encourage and facilitate the process of technological innovation. They directly influence the quality of ... education and manpower training that is essential for development of human scientific and technical resources. They support the vast majority of the nation's public institutions of higher education where most university research and development takes place. They provide significant technical, management and financial assistance to new and existing technology-based firms from which innovations to the market-place flow. Equally important, state governments are in a position to build the kind of partnerships with education and industry that stimulate innovation and help ensure its continued vitality and relevance."

Encouraged by the opportunity that technology offers in economic development, state governments are joining with the private sector, universities, and local governments to encourage technology application to modernize existing industries and to promote new technology-based business ventures. Many new partnerships initiatives have been initiated by state governments and a brief synopsis of some of these programs is provided.

State Initiatives in Technology:

Alabama

The Alabama Research Institute was created by the Governor in 1983 and appropriated from the general fund of the state was ten million dollars (\$10,000,000) for the support and encouragement of educational, agricultural, maricultural and industrial activities involving basic and applied scientific research and development. The appropriation was made from monies derived by the state from the leasing of rights in offshore oil, gas and other

hydrocarbon minerals. The institute makes grant awards as follows: Research Program Grants to support basic and applied research. Matching funds are not required for Research Project Grants, but such grants may be used cooperatively with funds from other sources. Institutional Challenge Grants shall not be project-oriented, but will seek to support institutional plans for permanent and significant enhancement of research capabilities in areas of potential economic significance to the state. An institution is required to match, dollar for dollar, a Challenge Grant award. Challenge grants may be used for such purposes as purchasing major items of research equipment, establishing centers for scientific research or endowing research chairs at an institution.

Arizona

The Center of Excellence established in 1980 at Arizona State University is designed to link industry with university resources, and to improve education in math, science, and computers. A total of \$32 million in public and private funds have been provided; the state's contribution consisted of a new building plus equipment for the engineering school.

California

The Microelectronics Innovation and Computer Science Research Program (MICRO) was established in 1982 by the California legislature. Current funding is \$2 million per year; every project must have at least 50 percent of its cost covered by industry.

Objective of MICRO is to help the California electronics and computer industries maintain their competitive edge by expanding research and graduate-student education at the University. Under the research part of the Program, faculty members on the several campuses submit proposals for research projects that will potentially be the basis for new industrial products some years in the future. The state and industry jointly support funded projects. Graduate-student education is supported both through research assistantships funded by the projects and through Fellowships granted directly to students in the fields covered by MICRO.

The Program is under the overall guidance of a Policy Board, composed of three representatives each from industry, the State Government, and the University.

Colorado

A Colorado Advanced Technology Institute (CATI) has been created by the Legislature. The Institute provides incentives to attract top faculty, increase research capabilities, and would improve the quantity and quality of university graduates in technological fields. CATI is requesting \$7 million from the Legislature for FY '85.

Florida

The Florida Commerce Department's Research and Development Commission provides incentives for R&D parks to be built in conjunction with state universities. Parks presently exist at four of the state's colleges. The University system set up an Industrial/Academic Council to coordinate engineering education at

the state's schools. The Council also provides linkages between programs and industrial needs.

Illinois

The Legislature created a fund known as the Technology Innovation and Commercialization Fund to be used to issue grants to universities and Illinois businesses for the purposes of fostering research and development in high technology and the services necessary to the development of new products which would be marketed by in-state businesses.

A Biomedical High-Tech Research Park is being built near Chicago to serve as a research center and incubator facility. The state has committed \$11 million to the project. Development of a Microelectronics Center at the University of Illinois is being planned, with an expected state investment of \$5.3 million.

Indiana

The Indiana Legislature established in 1983 the Corporation for Science and Technology (CST), to stimulate the development of new technologies, new processes and products and in the long run providing new employment opportunities. It is an independent, not-for-profit organization and performs three major functions:

- 1) provides policy guidance for the Governor and legislature on the role of technological innovation in strengthening Indiana industries;
- 2) develop programs to encourage innovation and technology;
- 3) provide a mechanism for the implementation of programs either through its own membership and funding or through the development of other resources.

In the 1983-1984 biennium, CST receives \$20 million from state appropriations. These funds are to be delegated at the rate of \$5 million for our first year and \$15 million for the second year. Thereafter, it is expected that CST will receive \$20 million per year for the rest of the decade. The Administrative budget for CST operations for the first year is \$400,000.

CST has a 24-member Board of Directors comprised of eight representatives each from the private sector, public sector, and university/education sectors.

Projects and programs of CST include:

- grants to universities for research that aids in the economic development of the State;
- "seed money" for organization and implementation of one or more Industrial Technology Institutes;
- matching funds for basic and/or applied research in targeted technologies to be managed jointly by universities and industry participants;
- preparation and consideration of proposals for research parks;

- matching funds to organize and start technology centers in various parts of the state; and
- creation and implementation of programs in conjunction with the National Science Foundation and/or other federal agencies.

The Corporation for Innovation Development (CID), a venture capital corporation established in 1981, is designed to encourage capital investment in Indiana, encourage expansion of business and industry, provide additional jobs, and encourage research and development. CID is a private for-profit corporation authorized to invest in new ventures and businesses unable to obtain financing from other sources and to invest in Small Business Investment Companies (SBICs). The Corporation is authorized to sell stock to private investors who will receive a 30 percent credit against their income tax liability. A proposal to allow the state's pension fund (Public Employees Retirement Fund) to invest up to five percent of its assets in debentures of CID was included in the Governor's economic development package which was presented to the General Assembly in 1983.

North Carolina

The Research Triangle Park was started in the late 1950's, and a Board of Science and Technology with the governor as chair has existed since 1963. Two current programs are of particular interest.

The smaller is the North Carolina Biotechnology Center, started in 1981. It conducts R&D and coordinates university/industry activities. State support to the Center in 1983 was over \$100,000.

The most publicized is the Microelectronics Center of North Carolina, based in the Research Triangle. Begun in 1980, it has received over \$43 million in state funds. State support for construction equipment, and operating expenses leverages funds received from industrial affiliates - funds that go into directed research. It provides advanced training and research in fields related to computers and electronics.

Ohio

A long-term program for a strategic planning process has been started to carefully assess the state's problems and assets and to carefully target the state's limited resources. Ohio is committed to making the long-term investments required in state businesses, new ideas, skills and education, infrastructure and natural resources. Indicative of this approach is its \$32 million Thomas Alva Edison Partnership Program. The program will provide grants for both early- and late-stage research and development, direct technology audit and search programs, to accelerate the commercialization of new innovations, and set up major technology application centers at state universities.

In July 1984 Ohio will award \$23.6 million for the establishment of six advanced technology application centers. Participating private sector firms are expected to match the state commitment, pushing the total investment in the centers to over \$47 million.

The centers will involve five major universities, and concentrate in welding and computerized information systems: advanced manufacturing; polymers; and recombinant animal biotechnology.

Calling the centers "a partnership between education, private enterprise and this administration," Governor Celeste maintained "they will focus our attention and resources on programs with real capability for creating jobs."

Massachusetts

The Massachusetts Technology Park Corporation, established in 1982 with \$20 million in state funds, is designed to improve ties between universities and industries and to establish training programs in emerging technologies. Current efforts are focused on microelectronics.

Michigan

The Industrial Technology Institute in Ann Arbor is designed to coordinate work by industries, universities, and community colleges in computer-based manufacturing, robotics, and retraining. \$2.75 million in state funds were provided.

The University of Michigan has established an Innovation Center which transfers new knowledge to existing firms so they can expand into new markets or products.

Wayne State University in Detroit has set up a Metropolitan Center for High-Technology. It has four main components:

- an expanded R&D capability,
- improved teaching facilities
- an incubator program for new firms, and
- an industrial training and retraining program.

Michigan State University has started a Molecular Biology Institute, using a combination of state funds and foundation grants. It will undertake a wide range of projects, with particular emphasis on those capable of early commercialization.

New Jersey

New Jersey voters in November 1984, election overwhelmingly approved a measure to allocate \$57 million to establish four high-technology research centers and \$33 million to improve high technology programs at public and private colleges and universities. These Centers will have state-of-the-art equipment to perform advanced research. Public support will be augmented by various private industry affiliates programs, which will contribute to the centers through memberships, matching grants, and in-kind forms of support.

Pennsylvania

The Ben Franklin Partnership Challenge Grant Program provides matching state funding to consortia of Pennsylvania's research universities, other higher

education institutions, business, labor and other groups and organizations through four regional advanced technology centers.

Each center provides:

- joint R&D efforts, in concert with the private sector, in specified areas such as robotics, biotechnology and CAD-CAM. (Areas vary by center.)
- education and training, assisting all higher education institutions to provide training and retraining in technical and other skill areas essential to assisting firm expansions and start-ups.
- entrepreneurial assistance services including linking R&D, entrepreneurs, venture capitalists, and other financial resources; assisting in preparation of business plans, feasibility studies; etc.

Additionally, centers may optionally provide small business incubator spaces and services, technology transfer activities and other services.

Each center was provided a \$250,000 grant for the first six months of effort. The \$1 million State funds generated \$4.1 million in private and university matching funds. The Governor's 1983-84 budget proposal includes a \$10 million annual appropriation for the centers. The State funds are expected to generate \$10 million in additional private and university funds.

Texas

Texas A&M has established the Institute for New Ventures in New Technology (INVENT). This program links university R&D efforts with entrepreneurs, and provides information on product financing and marketing.

Conclusion:

The foregoing examples show that numerous mechanisms for state government, industry and university cooperation currently exist or are being developed by state governments around the country.

The Governor's Advisory Council on Science and Technology recommendation for an Alliance for Science and Technology Development represents a similar opportunity for Montana.

APPENDIX D

UNIVERSITY SYSTEM BUDGET MODIFICATIONS

The Advisory Council on Science and Technology endorses and urges Legislative support for the following University System program modifications, which can significantly contribute to long-term economic development:

A. University of Montana:

(1) Forest and Conservation Experiment Station:

The Mission-Oriented Research Program in the Montana Forest and Conservation Experiment Station would be expanded to meet many priority needs identified by the Council's Forestry Technology Subcommittee. The program wishes to increase staff by adding 7.5 FTE's (2.5 FTE scientists and 5.0 FTE technicians). The first year includes the purchase of harvesting and processing equipment. Research would include genetics, density manipulation in timber stands, site amelioration and other topics. The transfer of information is planned.

(2) Master's of Business Administration Program (MBA) at Eastern Montana College:

The Billings area has over 150 prospective students wanting a MBA program and who are eligible for admission. The majority of potential students have full-time employment and are unable to move.

It will take two years before enrollment sustains the program through the funding formula, therefore, start-up funding is being requested.

(3) Biological Station - Yellow Bay on Flathead Lake:

Water quality is an important element in economic development. The purpose of this program modification is for maintaining the laboratory and expanding it into the region's finest freshwater research facility. Funds would supply additional staff, operation expenses, and additional instruments to raise the capability of the Laboratory to state-of-the-art. University intent is to also aggressively pursue private funds for the support of the laboratory.

B. College of Mineral Science and Technology:

(1) Energy and Mineral Technology Research:

Increased extraction and use of primary energy and mineral resources (oil and gas, coal, precious metals, strategic and critical minerals, the industrial minerals) provides significant economic opportunity. Realizing this economic potential depends upon technological innovation in mineral technology. Development and

sustaining of high quality research programs to produce this innovation requires consistent and long-range funding of research faculty and support staff.

Funding requested would strengthen three technology areas: 1) Coal research including chemical characterization, processing for sulfur and ash removal, thermal upgrading and alternative coal use; 2) Petroleum research including enhanced-oil-recovery technology, stratigraphic and physical analysis of petroleum source and reservoir rocks, tectonic analysis of the Overthrust Belt, development of deep crustal models; and 3) Hard-rock, mined-land reclamation including geotechnical research for reclaiming abandoned-mine lands, groundwater impacts and constraints on reclamation, biological impacts from mine reclamation, microbiological technology for mine-waste detoxification and revegetation for hard-rock mined land.

These modified funds will provide significant new opportunities to develop innovative technology to the Montana mineral industry.

C. Montana Bureau of Mines and Geology:

- (1) Mineral and Groundwater Information Services:
Information on Montana's mineral and groundwater resources continues to accumulate at numerous locations, by various agencies. This data is often inaccessible and incompatible among users. This program modification would provide staff, operating support and the necessary electronic equipment to develop a Resource Data Management System. This system would utilize existing data to build a groundwater and mineral resource information system, to respond to public inquiries regarding mineral resource potential, location and quality. Access to such information is critical to many land-use and mineral management decisions.

- (2) Coal Geology:
The Montana coal industry is critical to the state's economy. Average annual production of nearly 30 million tons per year of low sulfur, subbituminous coal provides nearly \$90 million annually in severance taxes, several thousand jobs and significant capital investment.

Concern over coal use as a factor in acid precipitation, and the intensifying research and technology development programs in eastern coal-producing states, are increasing demand for information and the quality and distribution of Montana coal resources. Coal quality investigations provide measures critical to assessing end use or appropriate beneficiation processes. If Montana coal producers are to meet the technological challenge posed by intensive research and development programs in other coal-producing states, and avoid further market erosion, research in coal characterization must be expanded.

This program modification would provide two coal geologists to begin coal quality investigations and the collection of subsurface coal samples. Results would be published as profiles of coal characteristics including the distribution, by coal seam and area, of quality factors, information essential to expanding use through technological innovation.

(3) Hard-rock Mined-land Reclamation:

Both government and the private sector are committed to reclamation. Reclamation practice must be tailored to specific conditions at individual sites, therefore, reclamation research must be based upon knowledge of local geologic and hydrologic conditions.

This request would develop a scientifically-based, practical hard-rock mined-land reclamation research and information program which would: 1) develop improved and less costly treatment technology for historic disturbed mine lands, and 2) provide an improved information base to support development of better and potentially less environmentally damaging new mines in Montana's characteristic climate and terrain.

This request would provide one hydrogeologist and one geological engineer to conduct essential research specifically to hard-rock mines. Program goals include providing mine developers with geologic and hydrologic data prior to mine development, training and information services in reclamation practice, design and maintenance of groundwater monitoring and modeling systems for impact prediction, and recommendations for identification, inventory and mitigation of mined-land subsidence.

D. Montana State University:

(1) Engineering Experiment Station (EES):

Three program areas have been targeted for support in this modification request. They are: 1) public works engineering, 2) power and communications systems engineering and 3) energy systems and materials engineering. They are areas that can serve economic development.

(2) Public Works Engineering:

Infrastructure decay in Montana and nationally has reached alarming proportions. Estimates of costs to repair facilities range from tens of millions of dollars in Montana to tens of billions of dollars nationally.

The EES would provide education, service and technology development in the areas of: transportation, municipal water supply and environmental engineering. One project would study the feasibility of renovation of deck truss bridges in Montana. Another proposed study would develop models of water usage patterns for use in the design and operation of municipal water systems.

(3) Power and Communication Systems Engineering:

The escalating costs of fossil fuels require optimized operations of every power entity. The Engineering Experiment Station would provide the advanced planning tools which the electric power industry needs to meet the increased demands for electrical energy while satisfying environmental concerns and financial restrictions. Tools to be developed include improved conventional generating, transmission and distribution facilities, together with new concepts in power generation, such as solar and wind-powered systems.

Other projects include development of a low cost "electronic ear tag" for livestock identification with large potential savings to the Montana livestock industry. Another project would identify high risk lightning areas where extra insulation is needed to protect transmission lines.

(4) Energy Systems and Materials Engineering:

Montana's economy relies on abundant, economical supplies of energy. The need exists for more efficient and environmentally acceptable energy production methods, innovative uses of alternative energy sources and economic techniques for converting Montana grains to useful energy forms.

New technologies in materials are developing rapidly and Montana manufacturers must continually upgrade materials to stay competitive.

The EES would develop research programs in: energy systems, including modification of carbon-based fuels to chemical forms that are clearer and more efficient, an extension of solar test laboratory work, and materials engineering, new materials and their applications including coal-derived materials, catalysis, composite materials and coal-based carbon materials.

One project would seek new technology to more efficiently obtain fuel ethanol and other useful chemicals from grain or from timber industry residues. A second project would investigate the amount of solar energy collected during time periods when solar radiation values are theoretically below the level required to produce energy gain; improved solar heating design methods are expected.

(5) Water Resources Research Center (WRRC):

Federal support to the WRRC program requires a matching state commitment. Support requested by this modification would enhance the university system's role in helping to manage the state's water resources.

The WRRC's role in water management is three-fold: 1) research that provides management tools to state water agencies, 2) training of professional people, and 3) information transfer.

(6) Alternative Uses of Agricultural Products (Agricultural Experiment Station):

The economy of Montana would also greatly benefit by increasing the value of its agricultural products by processing the products before shipping; in turn, shipping costs would be reduced.

The Montana Agricultural Experiment Station has engaged in research leading to valuable products. Examples include new crop varieties with better nutritional properties, higher quality forage and the utilization of distillers' by-products as animal feed and human food. Examples of potential new research areas include barley and wheat use in human food products, animal feed and new energy sources, safflower varieties adapted for energy applications, enhanced quality of specialty crops for small farms, and genetic engineering applied to Montana crop and livestock products.

A program leader in agricultural product utilization would be appointed and would undertake a research program. In addition, the program leader would encourage appropriate research proposals. Requested personal services support would include technicians, graduate students and hourly labor equivalent to five classified FTE. Personal services would be distributed on a competitive basis to support research. As projects are completed, the personal services support would return to a central pool for redistribution, again on a competitive basis. The leader would also actively solicit outside funds. Montana agriculture will be in a much better position to capture the potential offered by new science and technology if this research is supported.

(7) Business Development Assistance (Cooperative Extension Service):

The Cooperative Extension Service's extension outreach network exists to reach into the business community to coordinate service, assistance and referral. Initially, federal funds were used to support business assistance provided through the network and, at one time, more than 12 such positions existed in Montana. Presently, outside the Build Montana program, only one part-time business assistance position exists with the extension service network. Federal funding for this position ends in December 1984. Therefore, in order to continue this type of support from the Montana Cooperative Extension Service, financial assistance will be needed to support one position in business assistance.

E. University System:

(1) Modify Indirect Cost Policy:

In Montana, 85 percent of indirect costs reimbursement generated by research activities is appropriated as general revenue to meet formula funding requirements for instruction and other general unit operating costs. The 15 percent not appropriated remains with the originating institution to support growth of research programs. The 85 percent appropriated level is excessive and is a disincentive to support research activities. All indirect costs, which are legitimate costs incurred by the institution, should remain with the institution and be used to support research activities.

The Advisory Council also finds that the appropriation of vacancy savings to fund pay increases for research departments within the University System units results in reduced funding for maintenance of modern and effective research programs.

(2) Building Program:

The Advisory Council recognizes that expanded efforts in technical and scientific education and in research within the University System require additional capital expenditures for workspace, offices, laboratories and classrooms. The Advisory Council, therefore, endorses the funding of needed facilities, such as the Engineering and Physical Sciences Complex at Montana State University, the multi-use Technical Building at the Northern Montana College, and the Business Administration Building at the University of Montana, that provide and support training and education of business managers, scientists, engineering and other technical personnel as well as providing a research environment capable of supporting Montana industry.

APPENDIX E

TECHNOLOGY-INTENSIVE SECTORS IN MONTANA'S ECONOMY*

Technology-intensive sectors are defined as economic sectors whose proportions of scientific as well as combined scientific and technical workers are at least twice their state-wide averages of 1.8 and 3.7 percent, respectively. Scientific workers are defined as engineers, life and physical scientists, mathematical and computer specialists. Technical workers are limited to engineering and science technicians. The occupational data used to classify sectors were from an unpublished 1982 industry/occupation table for Montana, constructed by the Montana Department of Labor and Industry.

Montana's technology-intensive sectors are as follows:

A. Mining:

1. Gold and Silver Ores
2. Metal Mining Services
3. Crude Petroleum and Natural Gas

B. Manufacturing:

1. Sugar and Confectionery Products
2. Miscellaneous Publishing (catalogs, directories, maps)
3. Industrial Organic Chemicals (primarily ethanol)
4. Petroleum Refining
5. Primary Smelting and Refining of Nonferrous Metals (aluminum and lead)
6. Construction and Mining Machinery
7. General Industrial Equipment
8. Office and Computing Machines
9. Communication Equipment
10. Electronic Components and Accessories
11. Engineering, Scientific, and Research Instruments

C. Services:

1. Pipeline Transportation, except Natural Gas
2. Combination Electric and Gas Services
3. Services Related to the Exchange of Securities or Commodities (not brokers or dealers)
4. Computer and Data Processing Services
5. Research and Development Laboratories
6. Electrical Repair Services
7. Engineering, Architectural, and Surveying Services
8. Noncommercial Educational, Scientific, and Research Organizations
9. Services, Not Elsewhere Classified
10. Federal Government, excluding Hospitals and the Military
11. State Government, excluding Education and Hospitals

* Prepared by Phil Brooks, State Economist, Montana Department of Commerce, December 1984.

TABLE F - 1

DETAILED EMPLOYMENT FOR MONTANA'S PRIVATE
TECHNOLOGY-INTENSIVE ECONOMIC SECTORS *

1976 - 1984

Sector	SIC ¹ Code	1976 Jobs	1980 Jobs	1982 Jobs	1984 ² Jobs
Mining:					
Gold & Silver Ores	104	90	406	728	834
Metal Mining Services	108	234	213	83	192
Crude Petroleum & Natural Gas	131	670	601	918	945
Total Technology-Intensive Mining		994	1,220	1,729	1,975
Manufacturing:					
Sugar & Confectionery Products	206	440	458	435	321
Misc. Publishing (catalogs, directories, maps)	274	100	130	31	36
Industrial Organic Chemicals (primarily ethanol)	286	0	21	44	55
Petroleum Refining	291	978	1,045	1,065	929 ³
Primary Smelting & Refining of Non-ferrous Metals (alum. & lead)	333	1,100 ⁴	1,770 ⁴	1,291	(D)
Construction & Mining Machinery	353	52	28	79	65
General Industrial Equipment	356	49	46	27	(D)
Office & Computing Machines	357	2	0	18	(D)
Communication Equipment	366	8	11	30	(D)
Electronic Components & Accessories	367	89	311	211	250
Engineering, Scientific & Research Instruments	381	2	2	3	(D)
Total Technology-Intensive Manufacturing		2,820	3,822	3,234	3,205
Private Services:					
Pipeline Transportation, except Natural Gas	461	107	100	96	89
Comb. Electric & Gas Services	493	2,145	3,003	3,314	(D)
Services related to Exchange of Securities or Commodities (not brokers or dealers)	628	30	37	23	30
Computer & Data Processing Services	737	156	312	262	485
Research & Development Labs.	7391	26	49	58	73
Electrical Repair Services	762	134	206	208	233
Engineering, Architectural, & Surveying Services	891	1,094	1,410	1,427	(D)

TABLE F - 1
(cont.)

Sector	SIC ¹ Code	1976 Jobs	1980 Jobs	1982 Jobs	1984 ² Jobs
Noncommercial Educational, Scientific & Research Organizations	892	155	510	206	308
Services not elsewhere Classified	899	22	68	63	99
Total Technology-Intensive Private Services		3,869	5,695	5,657	6,041
Total Technology-Intensive Private Sectors		7,683	10,737	10,620	11,221

* assumes that a technology-intensive sector in 1982 is technology-intensive for all years

(D) - Data suppressed to avoid disclosure of individual firm characteristics

¹ Standard Industrial Classification Code

² Average for the first six months of 1984

³ Estimated employment without the strike at the Cenex plant

⁴ Excludes primary smelting and refining of copper

SOURCES:

1. Research & Analysis Bureau, Montana Dept. of Labor & Industry, 1990 Industry/Occupational Employment Projections for Montana, March 1983 and September 1984.
2. Research & Analysis Bureau, Montana Dept. of Labor & Industry, Montana Industry/Occupation Projections - 1985, June 1980.
3. Research & Analysis Bureau, Montana Dept. of Labor & Industry, "202 File", (unpublished 1984 information).
4. U.S. Bureau of the Census, County Business Patterns 1976: Montana, March 1978.
5. U.S. Bureau of the Census, County Business Patterns 1980: Montana, December 1981.

TABLE F - 2

MONTANA'S PRIVATE TECHNOLOGY-INTENSIVE EMPLOYMENT

HISTORY AND PROJECTIONS

1976 - 1990

Sector	1976 Jobs	1980 Jobs	1984 [*] Jobs	1990 Jobs	Percent Change 1976-1984
Tech. Int. Mining	994	1,220	1,975	2,536	99
Tech. Int. Manufacturing	2,820	3,822	3,205	3,263	14
Tech. Int. Services	3,869	5,695	6,041	7,046	56
Total Private Tech.	7,683	10,737	11,221	12,845	46
Total Private Non-Agri. Employment	185,400	210,200	212,000	NA	14

* averaged for the first six months of 1984

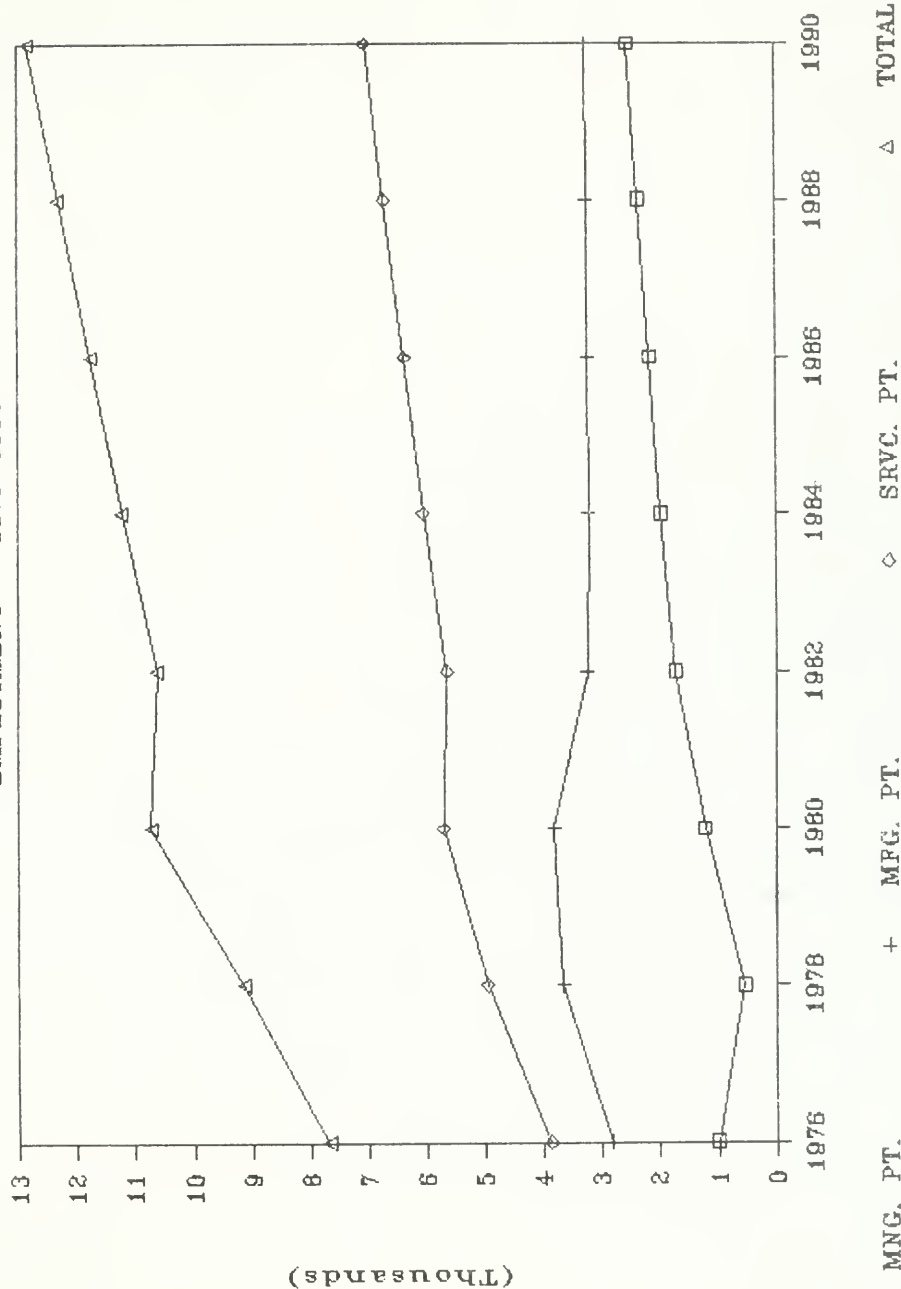
NA - not available

SOURCES: The above table was constructed using the detailed definition of technology-intensive economic sectors in Montana's economy from the following data sources:

1. Research & Analysis Bureau, Montana Dept. of Labor & Industry, 1990 Industry/Occupational Employment Projections for Montana, March 1983 and September 1984.
2. Research & Analysis Bureau, Montana Dept. of Labor & Industry, Montana Industry/Occupation Projections - 1985, June 1980.
3. Research & Analysis Bureau, Montana Dept. of Labor & Industry, "202 File", (unpublished data).
4. U.S. Bureau of the Census, County Business Patterns 1976: Montana, March 1978.
5. U.S. Bureau of the Census, County Business Patterns 1980: Montana, December 1981.

MONTANA TECHNOLOGY INTENSIVE SECTORS

EMPLOYMENT - 1976-1990



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